



美国商学院原版教材精选系列

PEARSON

物料管理入门

(第7版)

Introduction to Materials Management

Seventh Edition

[加] 托尼·阿诺德 (J. R. Tony Arnold)

[美] 斯蒂芬·查普曼 (Stephen N. Chapman) 著

[加] 洛伊德·克莱夫 (Lloyd M. Clive)

清华大学出版社

PEARSON



美国商学院原版教材精选系列

PEARSON

物料管理入门

(第7版)

Introduction to Materials Management

Seventh Edition

[加] 托尼·阿诺德 (J. R. Tony Arnold)

[美] 斯蒂芬·查普曼 (Stephen N. Chapman) 著

[加] 洛伊德·克莱夫 (Lloyd M. Clive)

清华大学出版社
北京

北京市版权局著作权合同登记号 图字：01-2012-2071

Original edition, entitled **Introduction to Materials Management**, 9780131376700 by **J. R. Tony Arnold, Stephen N. Chapman and Lloyd M. Clive**, published by Pearson Education, Inc., publishing as Prentice Hall, copyright © 2012.

All Rights Reserved. No part of this book may be reproduced or transmitted in any form or by any means, electronic or mechanical, including photocopying, recording or by any information storage retrieval system, without permission from Pearson Education, Inc.

China edition published by **PEARSON EDUCATION ASIA LTD.**, and **TSINGHUA UNIVERSITY PRESS** Copyright © 2013.

This edition is manufactured in the People's Republic of China, and is authorized for sale only in the People's Republic of China excluding Hong Kong, Macao and Taiwan.

For sale and distribution in the People's Republic of China exclusively (except Taiwan, Hong Kong SAR and Macao SAR).

仅限于中华人民共和国境内(不包括中国香港、澳门特别行政区和中国台湾地区)销售发行。

本书封面贴有 Pearson Education(培生教育出版集团)激光防伪标签,无标签者不得销售。

版权所有,侵权必究。侵权举报电话:010-62782989 13701121933

图书在版编目(CIP)数据

物料管理入门:第7版=Introduction to materials management 7:英文/(加)阿诺德(Arnold, J. R. T.), (美)查普曼(Chapman, S. N.), (加)克莱夫(Clive, L. M.)著.--北京:清华大学出版社,2013

(美国商学院原版教材精选系列)

ISBN 978-7-302-32314-3

I. ①物… II. ①阿… ②查… ③克… III. ①企业管理—物资管理—高等学校—教材—英文 IV. ①F273.4

中国版本图书馆 CIP 数据核字(2013)第 091975 号

责任编辑:贺岩

封面设计:漫酷文化

责任印制:李红英

出版发行:清华大学出版社

网 址: <http://www.tup.com.cn>, <http://www.wqbook.com>

地 址:北京清华大学学研大厦 A 座

邮 编:100084

社总机:010-62770175

邮 购:010-62786544

投稿与读者服务:010-62776969, c-service@tup.tsinghua.edu.cn

质量反馈:010-62772015, zhiliang@tup.tsinghua.edu.cn

印刷者:清华大学印刷厂

装订者:三河市新茂装订有限公司

经 销:全国新华书店

开 本:203mm×260mm 印 张:26

版 次:2013年6月第1版

印 次:2013年6月第1次印刷

印 数:1~5000

定 价:48.00元

产品编号:043229-01

教学支持说明

尊敬的老师：
您好！

为了确保您及时有效地申请教辅资源,请您务必完整填写如下教辅申请表,加盖学院的公章后传真给我们,我们将会 在 2~3 个工作日内为您开通属于您个人的唯一账号以供您下载与教材配套的教师资源。

请填写所需教辅的开课信息：

采用教材			<input type="checkbox"/> 中文版 <input type="checkbox"/> 英文版 <input type="checkbox"/> 双语版
作者		出版社	
版次		ISBN	
课程时间	始于 年 月 日	学生人数	
	止于 年 月 日	学生年级	<input type="checkbox"/> 专科 <input type="checkbox"/> 本科 1/2 年级 <input type="checkbox"/> 研究生 <input type="checkbox"/> 本科 3/4 年级

请填写您的个人信息：

学 校			
院系/专业			
姓 名		职 称	<input type="checkbox"/> 助教 <input type="checkbox"/> 讲师 <input type="checkbox"/> 副教授 <input type="checkbox"/> 教授
通信地址/邮编			
手 机		电 话	
传 真			
official E-mail(必填) (eg:XXX@crup.edu.cn)		E-mail (eg:XXX@163.com)	
是否愿意接受我们定期的新书信息通知：	<input type="checkbox"/> 是	<input type="checkbox"/> 否	

系/院主任：_____ (签字)

(系/院办公室章)

____年____月____日



清华大学出版社

北京市海淀区清华园学研大厦 B 座 506 室

邮编：100084

电话：8610-62770175-4506

传真：8610-62775511

E-mail: xuyy@tup.tsinghua.edu.cn

Website: www.tup.com.cn



Pearson Education Beijing Office

培生教育出版集团北京办事处

北京市东城区北三环东路 36 号北京环球贸易中心 D 座 1208 室

邮编：100013

电话：(8610)57355169/57355176/57355171

传真：(8610)58257961

E-mail: Service.CN@pearson.com

Website: www.pearsonhighered.com/educator

出 版 说 明

为了适应经济全球化的发展趋势，满足国内广大读者了解、学习和借鉴国外先进的管理经验，掌握经济理论前沿动态的需求，清华大学出版社与国外著名出版公司合作影印出版一系列英文版经济管理方面的图书。我们所选择的图书，基本上已是再版多次、在国外深受欢迎，并被广泛采用的优秀教材，绝大部分是该领域中较具权威性的经典之作。在选书的过程中，我们得到了很多专家、学者的支持、帮助和鼓励，在此表示谢意！

由于原作者所处国家的政治、经济和文化背景等与我国不同，对书中所持观点，敬请广大读者在阅读过程中注意加以分析和鉴别。

我们期望这套影印书的出版对我国经济科学的发展能有所帮助，对我国经济管理专业的教学能有所促进。

欢迎广大读者给我们提出宝贵的意见和建议，同时也欢迎有关的专业人士向我们推荐您所接触到的国外优秀图书。

清华大学出版社

2013. 4月

英/双语教学的成功路径与商科英文原版教材的效用

(代序)

在我国高校，用英语或双语教授专业课程（以下简称：英/双语教学）始于改革开放引进热潮，历经 30 年，虽发展不快，仍在缓慢推进。20 世纪 80 年代，改革开放后留学归来的教育界学者们不仅引进了各学科先进的研究成果，也随之引进了西方高校的教材。以清华大学出版社为领军的国内出版社适时地引进了西方优秀教材的影印版，推动了一些高校开始在专业课程中开展英/双语教学。2007 年以来，国家教育质量工程专设的“国家高校双语教学示范课程建设点”的评定项目被视为政府教育发展的政策风向标，正有力地推动着高校英/双语教学的发展。

但对英/双语教学的必要性，我国高校内部一直争议不断。争议首先围绕着中国人用英语教学的必要性。在公认英语是目前世界通用语言的前提下，英/双语教学的必要性取决于我国高校师生是否有必要及时汲取世界最新的研究成果。答案是不言而喻的。况且英/双语教学省却了翻译过程，可以避免常见的信息减损和曲解问题。不过，信息发布者——教师的英语演讲能力和信息接收者——学生的英语解读能力不足又成为开展英/双语教学的障碍。因而常见的反对意见是，开展英/双语教学，课堂教学内容就会缩水，因为讲授者和听众都得花费精力和时间解译内容。如此看来，我国开展英/双语教学的高校教师必须应对挑战，洞察在我国现有条件下用英文原版教材开展英/双语教学的利和弊，并找到可行的扬长避短的路径。

在经济开放和全球化的大趋势推动下，我国中小学英语教学分量加重，英语普及程度逐年提高，高校新生的英语基础愈益扎实；教师的英语能力也随着师资的新陈代谢而日见增强。这一趋势无疑在为英/双语教学营造越来越有利的条件。尽管如此，不同于以英语为主要语言或官方语言的一些国家，英语在我国的普及率仍较低。在青少年中，英语的普及程度和英语应用能力还仅处于初级水平；高校中能用英语演讲的教师尚属少数，且熟练程度还有待大幅提高。这样的师生英语基础，使得英/双语教学面临巨大的挑战。

同时，在多数的中国高校课堂里，教学任务多被视为逐章讲解某本教材的内容。本土中文教材通常是 400 ~ 500 页的 32 开本，含理论框架、主要知识点、计算方法和习题，但案例和故事不在其中，多由教师在讲解时添加，以演示和诠释理论要点。迄今仍然普遍盛行的“填鸭式”、“满堂灌”的传统教学法侧重于传授知识，从多数评教指标可见，只要学生感觉教师讲得精彩、有条理、能解惑，就算教学成功。

而引进的国外教材篇幅通常较长，16 开大本，500~800 页。习惯于上述传统教学法和评价标准的人们自然会产生一个疑问：在有限的课时内，这么厚的教材，怎么讲得完？其实，发达国家多数高校对学生阅读量的要求远远大于我国高校（即使是中文课本和资料），名校更是如此。它们的教材不仅涵盖理论框架和基本概念，而且富含长短不一、详简各异的演示性案例、故事和大量习题，总之它便于学生自学。课堂讲解只占一半课时，其余课时常被用于师生讨论和互动。于是，教师的讲解主要是勾勒理论框架，阐释重点和难点，还需针对事先布置的阅读资料和讨论题，引导学生展开讨论。可见，大厚本的教材适合于能力培训教学法。两者相辅相成，致力于调动学生

的主动性：他们必须大量阅读和思考，才能在课堂上有上好的表现，真正成为学习的主人。结果，他们的能力获得了必要和切实的磨炼。

由此可见，英/双语教学不只是教学语言的改变，它可以达到三重效用：传授专业知识；传授英语知识；同时训练专业方法和英语的应用技能。也因此，一些非英语国家的高校不惜成本，开展英/双语教学，使用与之相配的教材。对我国高校来说，要想成功开展英/双语教学，恐怕首先需要改变传统的教育思想和教学方法。换言之，如果高校想要使教育、教学接近世界先进水准，用英文原版影印教材开展英/双语教学是有效的途径。

迄今为止，原版英文教材的缺点也很明显。鉴于发达国家的作者是以其母国为背景，多数教材不涉及中国国情。教师必须在教学中紧密结合中国国情，提供相关案例、资料和思考讨论题，适时引导师生思辨现有理论的普适性，激励师生发现和创作适合我国国情的经济学、管理学、营销学规律。在我国作者编写和出版足量的优质英文教材之前，这些额外的工作必须由开展英/双语教学的教师来承担。

古今中外，成才之士都乐于阅读和探索，而这种氛围却在当今我国的大学校园里愈见淡化。加之中国学生相对薄弱的英语基础，目前英/双语教学仍面临很大的挑战：“填鸭式”的讲授与之相悖；仅靠课堂讲授和互动也很难奏效。但如能培养学生阅读和探索真理的兴趣，并营造一个全方位的孵化温床或生态环境，英/双语教学是有望成功的。根据能力培育过程的所需，这个生态环境包含师生对教育、教学的共识，好学求知的校风，富有挑战和师生互动的课堂教学，从课外讲座、项目操作到校园竞赛等第二课堂活动，便于师生交流的校园互联网等。

要做到这些，教师亟待与时俱进。随着师资的年轻化和高学历化，如今年轻教师的英语基础更好。但逆水行舟，不进则退。英语能力的进退取决于使用频率的多寡，其实英/双语教学过程既是加强英语使用、提高英语能力，也是汲取世界新知的最佳机会。不过，这一过程通常比用汉语教学的付出大得多，且因学生也需成倍地付出，英/双语教学的课程不容易像汉语教学课程那样容易在短期内获得学生的好评。因此给予英/双语教学的教师足够的激励成为生态环境的首要组成部分；缺乏对教师的足够激励，上述英/双语教学的生态环境就无法营造。

诚然，在教育体制和环境不够理想的情况下，教师和学生仍然有个人自训和奋斗的条件。英语原版教材影印版在我国的出版和更新就是对英/双语教学的及时支持。清华大学出版社近期又有一批英文原版影印教材出版，相信必将更进一步推动英/双语教学的发展。如今，已有一些本土高校的教师与英语国家的教师合著英文教材；在可见的将来，还会有中国教师编写发行到世界各地的英文教材。总之，及时用好英文原版影印教材，编写优质的英文教材是我国高校教师的历史责任。

愿英/双语教学的师资队伍愈益壮大，愿英/双语教学更加有力地推动我国教学方法与国际接轨，愿我国高校各级学生在英/双语教学中受益良多，茁壮成长！

对外经济贸易大学
傅慧芬

PREFACE

Introduction to Materials Management is an introductory text written for students in community colleges and universities. It is used in technical programs, such as industrial engineering and manufacturing engineering; in business programs; and by those already in industry, whether or not they are working in materials management.

This text has been widely adopted by colleges and universities not only in North America but also in other parts of the world. APICS—The Association for Operations Management recommends this text as the reference for certification preparation for various CPIM examinations. In addition, the text is used by production and inventory control societies around the world, including South Africa, Australia, New Zealand, Germany, France, and Brazil, and by consultants who present in-house courses to their customers.

Introduction to Materials Management covers all the basics of supply chain management, manufacturing planning and control systems, purchasing, physical distribution and quality management. The material, examples, questions, and problems lead the student logically through the text. The writing style is simple and user-friendly—both instructors and students who have used the book attest to this.

NEW TO THIS EDITION

- All chapters have been updated to reflect new techniques and technology
- Case studies added to Chapters 2: Production Planning System, 9: Inventory Fundamentals, and 14: Products and Processes
- Re-organized content to emphasize lean production separate from but related to JIT
- Extensive updates to Chapter 15: Lean Production
- End of chapter problems have been altered
- Addition of information on sustainability and “green” production

In addition, we have retained several features from previous editions:

- Margin icons to note key concepts
- Key terms listed at the end of each chapter
- Example problems within the chapters
- Chapter summaries
- Questions and problems at the end of each chapter

APPROACH AND ORGANIZATION

Materials management means different things to different people. In this textbook, materials management includes all activities in the flow of materials from the supplier to the consumer. Such activities include physical supply, operations planning and control, and physical distribution. Other terms sometimes used in this area are *business logistics* and *supply chain management*. Often, the emphasis in business logistics is on transportation and distribution systems with little concern for what occurs in the factory. Whereas some chapters in this text are devoted to transportation and distribution, emphasis is placed on operations planning and control.

Distribution and operations are managed by planning and controlling the flow of materials through them and by using the system’s resources to achieve a desired customer service level. These activities are the responsibility of materials management and affect every department in a manufacturing business. If the materials management system is not well designed and managed, the distribution and manufacturing system will be less

effective and more costly. Anyone working in manufacturing or distribution should have a good basic understanding of the factors influencing materials flow. This text aims to provide that understanding and also includes a chapter on quality management.

APICS defines the body of knowledge, concepts, and vocabulary used in production and inventory control. Establishing standard knowledge, concepts, and vocabulary is essential both for developing an understanding of production and inventory control and for making clear communication possible. Where applicable, the definitions and concepts in this text subscribe to APICS vocabulary and concepts.

The first six chapters of *Introduction to Materials Management* cover the basics of production planning and control. Chapter 7 discusses important factors in purchasing and supply chain; Chapter 8 discusses forecasting. Chapters 9, 10, and 11 look at the fundamentals of inventory management. Chapter 12 discusses physical inventory and warehouse management, and Chapter 13 examines the elements of distribution systems, including transportation, packaging, and material handling. Chapter 14 covers factors influencing product and process design. Chapter 15 looks at the philosophy and environment of just-in-time and lean production and explains how operations planning and control systems relate to just-in-time and lean production. Chapter 16 examines the elements of total quality management and six sigma quality approaches.

ONLINE INSTRUCTOR RESOURCES

To access supplementary materials online, instructors need to request an instructor access code. Go to www.pearsonhighered.com, click the **Instructor Resource Center** link, and then click **Register Today** for an instructor access code. Within 48 hours after registering you will receive a confirming e-mail including an instructor access code. Once you have received your code, go to the site and log on for full instructions on downloading the materials you wish to use.

ACKNOWLEDGMENTS

Help and encouragement have come from a number of valued sources, among them friends, colleagues, and students. We thank the faculty of other colleges and the many members of APICS chapters who continue to offer their support and helpful advice. Many thanks to those who reviewed the sixth edition and provided suggestions for the seventh edition, including members of the APICS Basics of Supply Chain Management Certification Committee: Jim Caruso (Chair) of Tyco Healthcare; Carol Bulfer, Parker Hannifin Corp.; William Leedale, IFS; and Angel Sosa, University of Puerto Rico at Bayamon. Academic reviewers included Sheila E. Rowe, North Carolina A&T State University; David Lucero, Greenville Technical College; Floyd Olson, Utah Valley State College; Ralph G. Kauffman, University of Houston—Downtown; Ronald J. Baker, Shoreline Community College; and Richard E. Crandall, Appalachian State University.

Tony Arnold thanks his wife, Vicky Arnold, for her assistance throughout the years of writing and revising this text, and Steve Chapman thanks his wife, Jeannine, for her support as well. Lloyd Clive thanks his wife, Kathleen, for her continued support.

Overall, this book is dedicated to those who have taught us the most—our students.

J. R. Tony Arnold, Professor Emeritus, CFPIM, CIRM
Fleming College
Peterborough, Ontario

Stephen N. Chapman, Ph.D., CFPIM, Associate Professor
Department of Business Management, College of Management
North Carolina State University
Raleigh, North Carolina

Lloyd M. Clive, CFPIM
Coordinator Materials Management and Distribution
School of Business
Fleming College
Peterborough, Ontario

CONTENTS

Preface ix

1 Introduction to Materials Management 1

Introduction 1 / Operating Environment 1 / The Supply Chain Concept 4 / What Is Materials Management? 9 / Summary 13 / Key Terms 13 / Questions 13 / Problems 14

2 Production Planning System 16

Introduction 16 / Manufacturing Planning and Control System 17 / Sales and Operations Planning 20 / Manufacturing Resource Planning 22 / Enterprise Resource Planning 23 / Making the Production Plan 24 / Summary 33 / Key Terms 33 / Questions 33 / Problems 34 / Case Study: Meridian Water Pumps 39

3 Master Scheduling 41

Introduction 41 / Relationship to Production Plan 42 / Developing a Master Production Schedule 44 / Production Planning, Master Scheduling, and Sales 49 / Summary 54 / Key Terms 55 / Questions 55 / Problems 56 / Case Study: Acme Water Pumps 61

4 Material Requirements Planning 62

Introduction 62 / Bills of Material 64 / Material Requirements Planning Process 70 / Using the Material Requirements Plan 81 / Summary 84 / Key Terms 84 / Questions 84 / Problems 85 / Case Study: Apix Polybob Company 95

5 Capacity Management 98

Introduction 98 / Definition of Capacity 98 / Capacity Planning 99 / Capacity Requirements Planning 100 / Capacity Available 102 / Capacity Required (Load) 105 / Scheduling Orders 107 / Making the Plan 109 / Summary 109 / Key Terms 110 / Questions 111 / Problems 111 / Case Study: Wescott Products 114

6 Production Activity Control 117

Introduction 117 / Data Requirements 120 / Order Preparation 121 / Scheduling 122 / Load Leveling 127 / Scheduling Bottlenecks 128 / Theory of Constraints and Drum-Buffer-Rope 130 / Implementation 132 / Control 133 / Production Reporting 138 / Product Tracking 139 / Summary 139 / Key Terms 139 / Questions 140 / Problems 141 / Case Study: Johnston Products 145

7 Purchasing 147

Introduction 147 / Establishing Specifications 150 / Functional Specification Description 152 / Selecting Suppliers 154 / Price Determination 157 / Impact of Material Requirements Planning on Purchasing 159 / Environmentally Responsible Purchasing 161 / Expansion of Purchasing into Supply Chain Management 162 / Some Organizational Implications of Supply Chain Management 163 / Summary 164 / Key Terms 164 / Questions 165 / Problems 165 / Case Study: Let's Party! 166

8 Forecasting 167

Introduction 167 / Demand Management 167 / Demand Forecasting 168 / Characteristics of Demand 168 / Principles of Forecasting 170 / Collection and Preparation of Data 171 / Forecasting Techniques 172 / Some Important Intrinsic Techniques 173 / Seasonality 176 / Tracking the Forecast 179 / Summary 185 / Key Terms 186 / Questions 186 / Problems 186 / Case Study: Northcutt Bikes: the Forecasting Problem 193

9 Inventory Fundamentals 196

Introduction 196 / Aggregate Inventory Management 196 / Item Inventory Management 196 / Inventory and the Flow of Material 197 / Supply and Demand Patterns 198 / Functions of Inventories 198 / Objectives of Inventory Management 199 / Inventory Costs 201 / Financial Statements and Inventory 203 / ABC Inventory Control 207 / Summary 210 / Key Terms 211 / Questions 211 / Problems 212 / Case Study: Randy Smith, Inventory Control Manager 216

10 Order Quantities 218

Introduction 218 / Economic-Order Quantity (EOQ) 219 / Variations of the EOQ Model 223 / Quantity Discounts 224 / Order Quantities for Families of Product When Costs are Not Known 225 / Period-Order Quantity (POQ) 226 / Summary 229 / Key Terms 229 / Questions 229 / Problems 230 / Case Study: Carl's Computers 234

11 Independent Demand Ordering Systems 237

Introduction 237 / Order Point System 237 / Determining Safety Stock 239 / Determining Service Levels 245 / Different Forecast and Lead-Time Intervals 247 / Determining When the Order Point Is Reached 247 / Periodic Review System 249 / Distribution Inventory 251 / Summary 254 / Key Terms 254 / Questions 255 / Problems 255

12 Physical Inventory and Warehouse Management 262

Introduction 262 / Warehousing Management 262 / Physical Control and Security 267 / Inventory Record Accuracy 268 / Technology Applications 273 / Summary 274 / Key Terms 274 / Questions 275 / Problems 275 / Case Study: CostMart Warehouse 278

13 Physical Distribution 282

Introduction 282 / Physical Distribution System 285 / Interfaces 287 / Transportation 288 / Legal Types of Carriage 290 / Transportation Cost Elements 291 / Warehousing 296 / Packaging 301 / Materials Handling 302 / Multi-Warehouse Systems 303 / Summary 305 / Key Terms 306 / Questions 306 / Problems 308 / Case Study: Metal Specialties, Inc. 309

14 Products and Processes 310

Introduction 310 / Need for New Products 310 / Product Development Principles 311 / Product Specification and Design 313 / Process Design 315 / Factors Influencing Process Design 316 / Processing Equipment 317 / Process Systems 318 / Selecting the Process 320 / Continuous Process Improvement (CPI) 322 / Key Terms 332 / Questions 333 / Problems 334 / Case Study: Cheryl Franklin, Production Manager 337

15 Lean Production 339

Introduction 339 / Lean Production 339 / Waste 341 / The Lean Production Environment 343 / Manufacturing Planning and Control in a Lean Production Environment: JIT Production 350 / Which to Choose: MRP (ERP), Kanban, or Theory of Constraints? 359 / Summary 361 / Key Terms 361 / Questions 362 / Problems 363 / Case Study: Murphy Manufacturing 364

16 Total Quality Management 367

Introduction 367 / What Is Quality? 367 / Total Quality Management (TQM) 369 / Quality Cost
Concepts 372 / Variation as a Way of Life 373 / Process Capability 375 / Process Control 379 /
Sample Inspection 382 / ISO 9000:2008 383 / Benchmarking 385 / Six Sigma 386 / Quality
Function Deployment 387 / JIT, TQM, and MRP 389 / Summary 390 / Key Terms 390 /
Questions 390 / Problems 391 / Case Study: Accent Oak Furniture Company 393

Readings 397

简 明 目 录

前 言	
第 1 章 物料管理简介	1
第 2 章 生产计划系统	16
第 3 章 主生产计划	41
第 4 章 物料需求计划	62
第 5 章 产能管理	98
第 6 章 生产作业控制	117
第 7 章 采购	147
第 8 章 预测	167
第 9 章 库存	196
第 10 章 订购量	218
第 11 章 独立需求订货系统	237
第 12 章 库存与仓库管理	262
第 13 章 实物配送	282
第 14 章 产品与流程	310
第 15 章 精益生产	339
第 16 章 全面质量管理	367
参考文献	397

INTRODUCTION TO MATERIALS MANAGEMENT

INTRODUCTION

The wealth of a country is measured by its gross national product—the output of goods and services produced by the nation in a given time. Goods are physical objects, something we can touch, feel, or see. Services are the performance of some useful function such as banking, medical care, restaurants, clothing stores, or social services.

But what is the source of wealth? Wealth is measured by the amount of goods and services produced, but where does it come from? Although we may have rich natural resources in our economy such as mineral deposits, farmland, and forests, these are only potential sources of wealth. A production function is needed to transform these resources into useful goods. Production takes place in all forms of transformation—extracting minerals from the earth, farming, lumbering, and fishing and using these resources to manufacture useful products.

There are many stages between the extraction of resource material and the final consumer product. At each stage in the development of the final product, value is added, thus creating more wealth. If ore is extracted from the earth and sold, wealth is gained from our efforts, but those who continue to transform the raw material will gain more and usually far greater wealth. Japan is a prime example of this. It has very few natural resources and buys most of the raw materials it needs. However, the Japanese have developed one of the wealthiest economies in the world by transforming the raw materials they purchase and adding value to them through manufacturing.

Manufacturing companies are in the business of converting raw materials to a form that is of far more value and use to the consumer than the original raw materials. Logs are converted into tables and chairs, iron ore into steel, and steel into cars and refrigerators. This conversion process, called *manufacturing or production*, makes a society wealthier and creates a better standard of living.

To get the most value out of our resources, we must design production processes that make products most efficiently. Once the processes exist, we need to manage their operation so they produce goods most economically. Managing the operation means planning for and controlling the resources used in the process: labor, capital, and material. All are important, but the major way in which management plans and controls is through the flow of materials. The flow of materials controls the performance of the process. If the right materials in the right quantities are not available at the right time, the process cannot produce what it should. Labor and machinery will be poorly utilized. The profitability, and even the existence, of the company will be threatened.

OPERATING ENVIRONMENT

Operations management works in a complex environment affected by many factors. Among the most important are government regulation, the economy, competition, customer expectations, and quality.

Government. Regulation of business by the various levels of government is extensive. Regulation applies to such areas as the environment, safety, product liability, and taxation. Government, or the lack of it, affects the way business is conducted.

Economy. General economic conditions influence the demand for a company's products or services and the availability of inputs. During economic recession the demand for many products decreases while demand for others may increase. Materials and labor shortages or surpluses influence the decisions management makes. Shifts in the age of the population, needs of ethnic groups, low population growth, freer trade between countries, and increased global competition all contribute to changes in the marketplace.

Competition. Competition is severe today.

- Manufacturing companies face competition from throughout the world. They find foreign competitors selling in their markets even though they themselves may not be selling in foreign markets. Companies also are resorting more to worldwide sourcing.
- Transportation and the movement of materials are relatively less costly than they used to be.
- Worldwide communications are fast, effective, and cheap. Information and data can be moved almost instantly halfway around the globe. The Internet allows buyers to search out new sources of supply from anywhere in the world as easily as they can from local sources.

Customers. Both consumers and industrial customers have become much more demanding, and suppliers have responded by improving the range of characteristics they offer. Some of the characteristics and selection customers expect in the products and services they buy are

- A fair price.
- Higher-(right) quality products and services.
- Delivery lead time.
- Better presale and after-sale service.
- Product and volume flexibility.

Quality. Since competition is international and aggressive, successful companies provide quality that not only meets customers' high expectations but exceeds them. Chapter 16 discusses quality in detail.

Order Qualifiers and Order Winners

Generally, a supplier must meet set minimum requirements to be considered a viable competitor in the marketplace. Customer requirements may be based on price, quality, delivery, and so forth and are called **order qualifiers**. For example, the price for a certain type of product must fall within a range for the supplier to be considered by potential customers. But being considered does not mean winning the order. To win orders, a supplier must have characteristics that encourage customers to choose its products and services over competitors'. Those competitive characteristics, or combination of characteristics, that persuade a company's customers to choose its products or services are called **order winners**. They provide a competitive advantage for the firm. Order winners change over time and may well be different for different markets. For example, fast delivery may be vital in one market but not in another. Characteristics that are order winners today probably will not remain so, because competition will try to copy winning characteristics, and the needs of customers will change.

It is very important that a firm understands the order winners and order qualifiers for each of its products and in each of its markets because they should drive the manufacturing strategy. Since it is virtually impossible to be the best in every dimension of competition, firms should in general strive to provide at least a minimal level of acceptance for each of the order qualifiers but should try to be the *best* in the market for the order winner(s).

One also should recognize that the order winners and qualifiers for any product/market combination are not static. Not only will customers change perspectives as competitors jockey for position, but the order winners and qualifiers will often change based on the

concepts of the product life cycle. The product life cycle implies that most products go through a life cycle, including introduction, growth, maturity, and decline. For example, in the introduction phase, design and availability are often much more important than price. Quality and delivery tend to have increased importance during growth, while price and delivery are often the order winners for mature products. This life cycle approach is complicated in that the duration of the life cycle will be very different for different products. Although some products have life cycles many years long, the life cycle of other products (certain toys or electronics, for example) can be measured in months or even weeks.

Manufacturing Strategy

A highly market-oriented company will focus on meeting or exceeding customer expectations and on order winners. In such a company, all functions must contribute toward a winning strategy. Thus, operations must have a strategy that allows it to supply the needs of the marketplace and provide fast on-time delivery.

Delivery lead time From the supplier's perspective, delivery lead time is the time from receipt of an order to the delivery of the product. From the customer's perspective, it may also include time for order preparation and transmittal. Customers want delivery lead time to be as short as possible, and manufacturing must design a strategy to achieve this. There are four basic strategies: engineer-to-order, make-to-order, assemble-to-order, and make-to-stock. Customer involvement in the product design, delivery lead time, and inventory state are influenced by each strategy. Figure 1.1 shows the effect of each strategy.

Engineer-to-order means that the customer's specifications require unique engineering design or significant customization. Usually the customer is highly involved in the product design. Inventory will not normally be purchased until needed by manufacturing. Delivery lead time is long because it includes not only purchase lead time but also design lead time.

Make-to-order means that the manufacturer does not start to make the product until a customer's order is received. The final product is usually made from standard items but may include custom-designed components as well. Delivery lead time is reduced because there is little design time required and inventory is held as raw material.

Assemble-to-order means that the product is made from standard components that the manufacturer can inventory and assemble according to a customer order. Delivery lead time is reduced further because there is no design time needed and inventory is held ready for assembly. Customer involvement in the design of the product is limited to selecting the component part options needed.

Make-to-stock means that the supplier manufactures the goods and sells from a finished-goods inventory. Delivery lead time is shortest. The customer has little direct involvement in the product design.

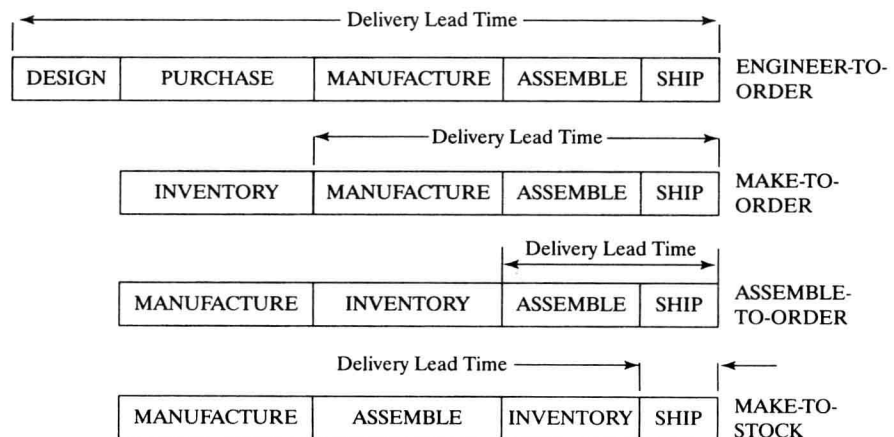


FIGURE 1.1 Manufacturing strategy and lead time.

Postponement is another application of assemble-to-order, described by the Association for Operations Management (APICS) as “a product design strategy that shifts product differentiation closer to the consumer by postponing identity change to the last possible supply chain location.” This strategy reduces the number of different items in the supply chain, lowering the amount of in-process inventory.

Computer printers for a global market use universal power supplies that can be switched to different voltages; on receipt of a customer's order, they are packaged with the appropriate cords, instructions, and labeling. This avoids filling an entire supply chain with expensive printers destined for different countries. Some basic postponement can be done in a distribution center and often by third parties. Foreign suppliers of appliances such as vacuum cleaners destined for multiple customers postpone the packaging of their products, applying customer-specific labels, bar codes, boxes, instructions, and so forth until after receipt of the customer order.

THE SUPPLY CHAIN CONCEPT

There are three phases to the flow of materials. Raw materials flow into a manufacturing company from a physical supply system, they are processed by manufacturing, and finally, finished goods are distributed to end consumers through a physical distribution system. Figure 1.2 shows this system graphically. Although this figure shows only one supplier and one customer, usually the supply chain consists of several companies linked in a supply/demand relationship. For example, the customer of one supplier buys a product, adds value to it, and supplies yet another customer. Similarly, one customer may have several suppliers and may in turn supply several customers. As long as there is a chain of supplier/customer relationships, they are all members of the same supply chain.

There are a number of important factors in supply chains:

- The supply chain includes all activities and processes to supply a product or service to a final customer.
- Any number of companies can be linked in the supply chain.
- A customer can be a supplier to another customer so the total chain can have a number of supplier/customer relationships.
- Although the distribution system can be direct from supplier to customer, depending on the products and markets, it can contain a number of intermediaries (distributors) such as wholesalers, warehouses, and retailers.
- Product or services usually flow from supplier to customer; design and demand information usually flows from customer to supplier. Rarely is this not so.

Although these systems vary from industry to industry and company to company, the basic elements are the same: supply, production, and distribution. The relative importance of each depends on the costs of the three elements.

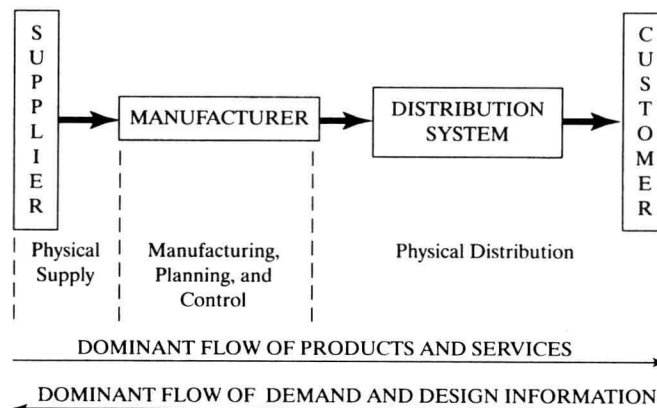


FIGURE 1.2 Supply-production-distribution system.